PSRR Measurement for LDO

PSRR is the abbreviation for the Power Supply Rejection Ratio, which refers to the ratio of input ripple to output ripple and is usually expressed in logarithmic form.

$$PSRR = 20 \times \log\left(\frac{Ripple(VIN)}{Ripple(VOUT)}\right)$$

The unit is decibel (dB). For example, 60-dB PSRR means that when the input ripple is 1 V, the output ripple will be 1 mV.

There is a need for ripple suppression in many application scenarios, so the PSRR of the LDO becomes crucial. Usually, the DCDC converter is used as the first stage to convert high voltage to low voltage, and the LDO is used as the second stage for voltage regulation and ripple filtering, providing power to terminal devices. For example, the power supply of a camera requires an LDO with an output voltage of 2.8 V or 2.9 V, and the input voltage of the LDO is generally provided by a DCDC converter. Typically, the switching frequency of DCDC converters is in the range of several hundred kHz to several MHz, so the PSRR of LDO products above 100 kHz needs to be strictly designed.

The TPL9032 series is a high-PSRR low-noise linear regulator designed by 3PEAK.

When the output current of the TPL903228 is 10 mA, the device has the following PSRR performance versus ripple frequency:

- 87.9 dB PSRR at 10 kHz
- 61.4 dB PSRR at 100 kHz
- 44.7 dB PSRR at 1 MHz

How to Measure PSRR?

Using an Oscilloscope and an Amplifier

The first method measures PSRR with an oscilloscope and an amplifier. The amplifier is used to superimpose the AC ripple on the DC voltage of the power supply, and then the output ripple and input ripple of the LDO are directly measured using an oscilloscope. However, this method is not suitable for high-PSRR LDOs because the output ripple is too small to be measured accurately by the oscilloscope. ⇐

Figure 1. Input and Output Ripples of LDO Measured Using an Oscilloscope

Source： experimental data

Using an Audio Analyzer and Amplifier

The second method measures PSRR with an audio analyzer and an amplifier. The audio analyzer itself does not have the ability to generate DC voltage and has weak driving capability. It needs to be connected to a high-bandwidth, large-current op amp to superimpose the AC ripple on the DC voltage of the power supply, and then applied to the input of the LDO. However, due to the bandwidth limitation of the audio analyzer, PSRR at a frequency above 100 kHz cannot be measured. The connection method is shown in the following figure:

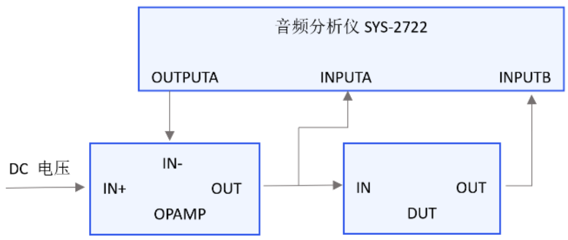


Figure 2. PSRR Measurement for LDO with an Audio Analyzer and an Op Amp

Source： self-made

Using a Network Analyzer

The third method is to measure PSRR with a network analyzer. Figure 3 shows the accurate PSRR measurement of LDO: E5061B combined with the Picotest line injector J2120A.

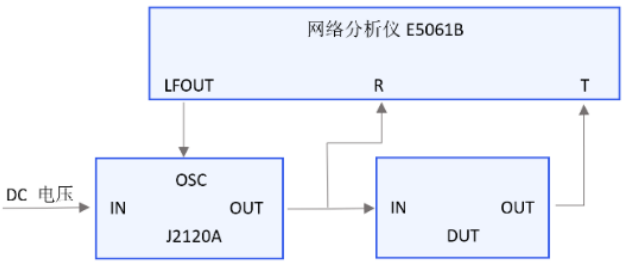


Figure 3. PSRR Measurement for LDO with Network Analyzer and J2120A

Source： self-made

Picotest J2120A can support up to 50-V voltage input and 5-A input current. It can directly superimpose the AC ripple and the DC voltage of the power supply. However, after passing through the J2120A, the voltage input to the LDO input terminal will be decreased. The E5061B can collect ripple voltage values at the input and output terminals of the LDO, so it can obtain accurate PSRR measurement results.

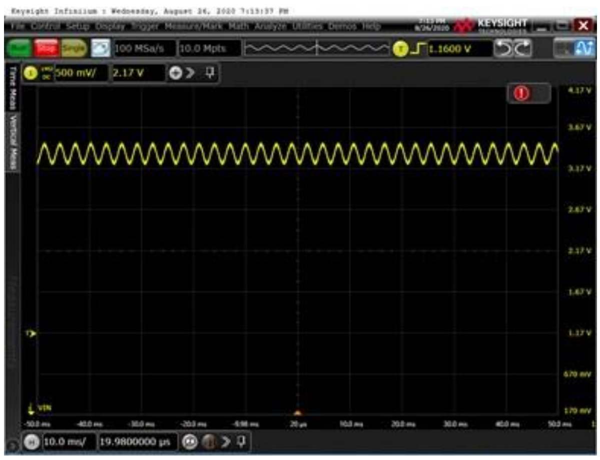


Figure 4. Output Waveform after Passing through the J2120A

Source： experimental data

From Figure 4, it can be seen that the AC ripple output by the network analyzer has been superimposed on the DC voltage of the power supply after passing through the J2120A, and then input to the LDO to be tested. Finally, the input and output ripples of the LDO are respectively measured by the R and T channels of the network analyzer.

Notifications for Measuring PSRR

1. Using an oscilloscope to monitor the input waveform during the measurement and observe whether the AC waveform at the VIN end is normal or not.

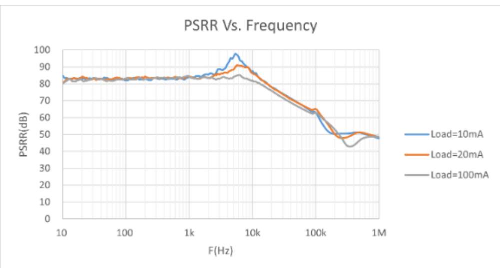
2. When measuring PSRR, it is recommended to add a 0.1-μF capacitor to the input of the LDO to avoid instability with a load current, which may result in inaccurate PSRR measurement.

3. After passing through Picotest J2120A, the output voltage will be decreased, so the VIN voltage needs to be increased appropriately.

4. Do not use an electronic load for the output load of the LDO, it is recommended to use a power resistor.

5. It is recommended to use coaxial cables to connect the input and output terminals of the LDO to the network analyzer.

The following figure shows the relationship between the measured PSRR and the frequency of the input AC ripple.



Source： experimental data

The following table shows the PSRR values of TPL903228 at several typical frequency points under different loads.

	IOUT=10mA	IOUT=20mA	IOUT=100mA
F(Hz)	PSRR(dB)	PSRR(dB)	PSRR(dB)
100.00	82.08	82.70	83.27
1k	87.9	86.18	81.90
5k	95.88	88.46	84.13
10k	61.4	65.03	62.96
100k	51.08	51.30	46.85
1M	44.7	48.47	48.57

The TPL9032 is a high-PSRR low-noise LDO that can provide an output current of up to 300 mA. Its input voltage range is from 1.7 V to 5.5 V, and the output voltage range is from 0.75 V to 5 V. The TPL9032 also has over-temperature and over-current protection features. The TPL9032 is an ideal power supply for RF, PLL, VCO, clock, low-noise amplifier, and camera applications due to its high-PSRR and low-noise features.